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A New and Reusable Foundation Solution for Onshore Wind Turbines

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Extended Abstract

Modern wind turbines are designed to withstand approximately for a lifetime of 20 years [1]. However, a very long design life of 100 years or more can be expected for high-quality concrete foundations. Thus there is a big difference in lifetime between wind turbines and foundations. There is a significant economic benefit of replacing the out-of-date wind turbine with a new turbine of better power generation capacity and reuse the existing foundation. However, the blades in modern turbines evolve to be longer, lighter and more efficient due to the rapid evolution of blade design which means a significant change in the design loads on the foundations. The big difference in lifetime and the major shift in the design loads show a potential for new and reusable foundation solution to allow wind power sites to be updated with taller and larger units in order to increase the energy production. A new foundation solution using a raft with an active stabilisation system is proposed in this study. The concept of an active stabilisation system is a novel idea using a movable load to stabilise against the overturning moment. The active stabilisation system consists of a water tank. The water tank is divided into eight compartments, and the system uses water as a movable load. Water will be in a number of compartments to stabilise against the overturning moment. Water position will rely on the wind direction. The water movement system depends on some electric motors and pipes with electric valves. The geotechnical performance of the new foundation solution is investigated in two studies using two existing weak soil profiles in Egypt and Sweden [2, 3]. The main result of these studies was that using a raft with an active system decreases the tilting compared to a piled raft with long friction piles. Moreover, it was found that the foundation budget is decreased in the case of using a raft with an active system compared to a piled raft with long friction piles.

One of the advantages of the new foundation solution is that the stability moment can be increased by filling more compartments with water. The present study focuses on comparing the allowable load capacity of the mentioned foundation solution and a raft foundation according to bearing capacity considering four soil profiles. The results show that the stability moment using the new solution can be increased by almost 41%. Also, the results show that the new foundation system gives a substantial improvement of the foundation load capacity compared to the traditional foundation solution. The improvement of the load capacity in the case of weak soils is increased by 48% ~ 67% compared to a traditional raft foundation. The improvement of the load capacity in the case of strong soils is increased by 23% ~ 32% compared to a traditional raft foundation.

References

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